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(56) References cited:
DE-A- 2 306 294
GB-A- 1 604 669
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Description

This invention relates to AM, FM, TV, Radar etc., transmitters and the means for reducing the energy level of the undesired rf harmonics at the output of the transmitter. The invention is especially useful for high power transmission systems where the size and cost of conventional means for reducing the magnitude of the undesired rf harmonics can be substantial.

Radio, Radar, Television and other wireless communication and navigation systems must restrict their bandwidth so as to avoid interfering with other users of the radio spectrum. One mechanism for causing interference is by radiating rf harmonics i.e., bands of rf power centered at exact multiples of the desired radiated signal's frequency. For example, if an AM broadcast station is assigned a carrier frequency of 660 kHz its 2nd harmonic will fall at 1320 kHz and its 3rd harmonic at 1980 kHz, etc. These harmonics can, if they are of sufficient magnitude, interfere with stations which operate at, or close to, the frequency of the harmonics.

Accordingly, regulatory agencies require stations to severely limit the radiated power of such harmonics. For example, the U.S. Federal Communications Commission requires all harmonics to be 43 + 10 log P decibels, but not more than 80 db, below P, the unmodulated carrier power of the station in watts.

In order to achieve relatively high efficiency, high powered rf amplifiers use tubes or transistors biased to conduct current less than the full rf cycle. This non-linear operation produces significant levels of harmonics that must be greatly attenuated prior to reaching the associated antenna. The present invention provides means and methods for providing improved methods and means for providing attenuation of rf harmonics.

The conventional prior art method of attenuating harmonics is to use a bandpass filter comprising tuned circuits which are tuned to the desired frequency, generally, but not always, the fundamental frequency component. (Sometimes the final amplifier is used as a frequency multiplier, in which case the tuned circuit is tuned to the desired harmonic and the tuned circuit is used to attenuate the fundamental and the remaining undesired harmonics.) This arrangement is effective, however the amount of attenuation per tuned circuit section is limited because of a number of reasons including;

1) The higher the selectivity factor, Q, the higher the circulating current which increases the size and cost of the inductor and capacitor in the tuned circuit.

2) The higher the selectivity factor, the greater the attenuation of the higher frequency sidebands of the modulated wave.

3) The higher the selectivity factor, the lower the efficiency. Thus for a single tuned circuit filter the efficiency of the tuned circuit in passing the rf wave is:

$$\text{Efficiency} = 1 - \frac{Q\text{ loaded}}{Q\text{ unloaded}}$$

where Q unloaded is the Q of the tuned circuit without the output load connected and Q loaded is the Q with the load connected. Typical values of Q unloaded are 200 to 800 and Q loaded 3 to 15. If the Q loaded is 13 a typical class C amplifier will have a 2nd harmonic down only approximately 30 db. For an unloaded Q of 260, approximately five % of the total power is wasted.

Push-pull amplifiers are useful in reducing the level of even order harmonics, but such circuits have a tendency to be unstable and do not reduce odd order harmonics.

Other circuits, such as Pi networks, are more effective than simple tuned circuits, but the difference is not substantial enough to solve the problem.

While there are and have been a number of products in the marketplace that manually and or automatically null harmonics (for example distortion meters) no r.f. harmonics attenuator following the method and means as disclosed herein is known. It is noteworthy that the problem this invention treats was known since the very earliest days of radio engineering. Because the subject invention can save approximately 30% of manufacturing costs of high powered radio and TV transmitters, can substantially reduce the size of the overall transmitter, and can significantly reduce the amount of electric power consumed, the invention solves a long standing need and has substantial utility.

A characteristic advantage and feature of the present invention is that the attenuation of harmonics can be accomplished with higher efficiency than conventional prior art methods. Furthermore, the invention can provide attenuation of undesired sideband components with substantially less attenuation of desired sideband components.

Another advantage of the present invention is that the necessary mechanical and electrical components are substantially smaller than the components required for the conventional method. A further advantage of the present invention is that the cost of the necessary equipment is substantially lower than of methods used heretofore.

The invention is particularly suitable for attenuating harmonics in AM, FM, TV and radar transmitters, i.e. virtually all high powered transmitters.

The invention accomplishes the task of reducing the amplitude of undesired radio frequency (r.f.) harmonics by providing at least a second path, which includes a power amplifier, for the undesired r.f. harmonics and causing the harmonics in the second path to have correct amplitude and phase to substantially cancel the undesired harmonics when they are combined with the main signal in the normal path. In a pre-

ferred embodiment of the invention, the second path also incorporates means for substantially attenuating the desired r.f. signal, generally the fundamental r.f. component.

The circuitry coupling the output of an high powered final amplifier and the associated antenna has always been passive. Active circuits in such applications would have been expensive and inefficient. Thus radio engineers throughout the world have consistently used passive circuits to couple power amplifiers to antennas. In the instant invention, one or more shunt paths are provided which, because they are only required to handle undesired components that typically have been reduced to 30 or 40 db below the desired main component, can be conditioned with active circuits, of reasonable size, to help further reduce their level. In other words, the feasibility of this new method is dependent on conditioning the wave generated in the high powered amplifier so as to reduce the power of the undesired components to a small percentage of the desired output. If this processing was not performed, the power level of the undesired components would be too great to treat with active circuitry and the technique would destroy the transmitter's overall efficiency. Furthermore, the system's adjustments would be much more delicate.

Thus, the invention is only practical if the attenuation provided by the main coupling circuit, between the final power amplifier and the antenna, is at least 6 decibels (db) greater for the undesired rf harmonic components than the desired signal.

Embodiments of the invention include manually adjusted phase and amplitude correction circuits in the second path as well as embodiments that incorporate automatic phase and amplitude adjustments.

Other features and advantages of the invention will be apparent from the following description and discussion of certain typical embodiments of the invention.

FIG. 1 is a simplified Block Diagram of one embodiment of the invention incorporating manual adjustments of the circuits for minimizing the level of undesired harmonics.

FIG. 2 is a simplified Block Diagram of another embodiment of the invention incorporating automatic minimization of the level of the undesired harmonics.

FIG. 1 shows one embodiment of the invention where the output of vacuum tube 102 comprises a desired fundamental component and undesired r.f. harmonics. The plate voltage, which may include an audio term for modulation purposes, is fed to the tube through choke, RFC 104. Coupling capacitor 106 couples the r.f. wave to a Pi network comprising capacitor 108, inductor 110 and capacitor 112. The Pi network, which provides a main path between the power amplifier tube and the antenna, serves a number of purposes, including reducing the impedance level suitable for operation of tube 102, to the load value connected to connector 114 and reducing the level of the harmonics present at the output of tube 102. While the Pi network reduces the level of the harmonics, causing the 2nd harmonic to be down in the order of 40 db below the fundamental, it is generally necessary to further attenuate at least the first few harmonics.

The output side of coupling capacitor 106 also feeds HPF (high pass filter) 116 which, assuming the desired output is the fundamental component and not a harmonic, substantially rejects the fundamental and passes the undesired harmonics. The harmonics that are above an acceptable level in the main or first path (the Pi network) are passed by bandpass filter 118, 118′, 118″ etc. The isolated harmonics are then phase shifted by phase shifters 120, 120′, etc so as to cause the selected harmonics, to be, when they reach the output terminal, 114, substantially 180 degrees out of phase with each corresponding harmonic from the first path, i.e., through the Pi network.

The output of the phase shifters are fed through power amplifiers 122, 122′, etc with adjustable power outputs so that the power that passes through each harmonic coupler 124, 124′ etc. is substantially equal to the power in each harmonic as passed through the Pi network path. This causes the harmonics to be greatly attenuated and allows active elements to be incorporated in special alternate paths for undesired harmonic components. Power amplifiers 122, 122′ are of different power levels, i.e. generally the lower harmonic orders, 2nd or 3rd, require higher power capability in the order of only 100 to 300 watts for a megawatt transmitter, while 4th or 5th order harmonics will require a few watts. Linear amplifiers are preferred especially if the harmonics from the main path are amplitude modulated.

In order to manually adjust the phase and amplitude of the harmonic component in the 2nd path it is convenient to provide a harmonic monitor 128 comprising bandpass filter/amplifier 130, 130′ etc detector 132, 132′ and meters 134, 134′ etc. Monitor 128 is coupled to the output line via pick up loop 126.

Although the circuitry discussed was designed for use of the invention for fundamental frequency operation, it will be apparent to those skilled in the art that by retuning filters 116 and 118 in FIG. 1 and 216 and 218 in FIG. 2 and changing the Pi networks to favor the desired harmonic allows operation of the circuits as frequency multiplier.

FIG. 2 shows an embodiment of the invention incorporating one possible means for automatically adjusting the phase and amplitude of the second path undesired harmonics so as to best minimize the energy of the second harmonic term in the final transmitted signal. Other harmonics, of sufficient amplitude to require additional suppression, are treated in the same manner as shown for the 2nd harmonic.

Tube 202, which in one application would be a

high power tube operating in a Class C mode, receives it plate voltage through an RF choke 204. Coupling capacitor 206 blocks the d.c. voltage feed to the Pi coupling circuit comprising capacitors 208, 212 and inductor, 210, a circuit that passes the fundamental component with little attenuation and greatly attenuates the rf harmonics. The Pi network in the main path also transforms the impedance of the load connected to output connector 214, generally 50 ohms, to a higher, more suitable impedance for the operation of tube 202.

Filter 216, which is also connected to the anode of vacuum tube 202 through capacitor 206, attenuates the fundamental component and feeds filters designed to pass the undesired harmonics that require additional attenuation beyond the attenuation provided by the Pi network.

Examining the operation of the means used to attenuate the 2nd harmonic component, the output of filter 216 includes the 2nd harmonic component which is passed by band pass filter 218. The output of filter 218 feeds phase shifter 220 which in turn feed variable gain amplifier 222 which then feeds power amplifier 224. Amplifier 224 is a linear amplifier that must amplify the 2nd harmonic component at a power level at the output of coupler 226 equal to the power level of the 2nd harmonic from the first path. Thus, the power produced by amplifier 224 must be high enough to accommodate the loss in coupling network 226. Thus network 226 should be tuned to the 2nd harmonic so as to minimize loss but should have high enough output impedance at the fundamental frequency so as to avoid loading the desired output component. One skilled in the applicable art will recognize there are a number of different designs available for network 226 including a T circuit with arms comprised of series tuned circuit and the junction of the arms connected to a parallel tuned circuit all circuits tuned to the 2nd harmonic.

As was true of the corresponding circuits in FIG. 1, phase adjust circuit 220 and variable gain amplifier 222 circuits cause the phase to be 180 degrees out of phase with the 2nd harmonic component from the main path (i.e., the Pi network path) and equal in amplitude. If these conditions are closely achieved, the 2nd harmonic component will be greatly attenuated.

The adjustments are automatically made as follows; a sample of the output connected to connector 214 i.e., is divided by resistive divider 228 and 230. Bandpass filter 232, fed by the divider, selects the 2nd harmonic which is detected by detector 234 producing a dc voltage which is proportional to the 2nd harmonic output. The dc voltage is amplified by block 236, which in turn feeds Dual ROM circuit 238. For correction to extremely low levels, it may be desirable to incorporate amplification means between filter 232 and detector 234.

Dual read only (ROM) Block 238, which may comprise two ROMs determines, from the level of the detected 2nd harmonic, how much sweep voltage should be produced for searching for a null of the 2nd harmonic for the phase and amplitude correction of the 2nd harmonic. The necessary phase correction sensitivity information can be stored in one ROM and the information regarding the amplitude sensitivity in the second ROM. This information will allow the circuits to "zero in" for the best null in the shortest period of time and once the circuit achieves the desired specification the circuit sweeps back and forth within very small margins.

Thus when the circuit is first activated, the system will force the circuits to sweep over a large range as commanded by the large 2nd harmonic output present at the junction of resistors 228 and 230. The nulling adjustments are achieved as follows. First let us consider the phase adjust circuit. A low frequency square wave, say a 1 Hz square wave, is generated by block 240. The positive leading edge of the square wave is fed to Gate 1 (block 242) causing it to connect the output of attenuator 250 to the control lead of phase adjust circuit 220. The square wave at the output generator 240 is integrated by block 248 so as to produce a linearly increasing wave during the period gate 242 connects attenuator 250 to the phases adjust circuit 220. When the phase adjust circuit 220 causes the detected 2nd harmonic to go through a null ie., just as the level increases out of the null, null detector 260 switches the gate 1 off leaving the null voltage stored in capacitor 256.

Similarly VGA 222, Gate 244, attenuator 254, integrator 252 and phase inverter 246 cause the alternate period of the square wave to cause gate 2, 244 to connect VGA 222 to attenuator 254 and produce a variation in amplitude of the 2nd harmonic from path 2 to move through a null as detected by 260. This action occurs during the negative period of the square wave at the output of generator 240. When an amplitude null is achieved, the circuit operates to store the proper control voltage in capacitor 258.

As the 2nd harmonic is increasingly attenuated the output of the attenuators 250 and 254 are reduced and the accuracy of the balance improves, causing further attenuation of the 2nd harmonic.

In all cases, it is understood that the above-described arrangements are merely illustrative of the many possible specific embodiments which represent applications of the present invention. Numerous and other varied arrangements can be readily devised in accordance with the principles of the present invention without departing from the spirit and scope of the invention.

Claims

1. A system for reducing the power of any undesired

harmonically related component in a radio frequency (rf) power signal to be transmitted by a transmitter;

characterised by:

a first path for coupling the output of a power amplifier (102,202) to an output terminal (114,214), said first path passing said signal while attenuating the or each said undesired component by at least 6 db;

a second path for selectively passing a said undesired component from said power amplifier (102,202) to said output terminal (114,214);

said second path including phase control means (120,220) and amplifier means (122,222) operable to cause the undesired component to reach said output terminal with a phase and amplitude relative to the phase and amplitude of the corresponding component reaching said terminal from the first path to tend to reduce the power of the undesired component at said output terminal.

2. A system according to Claim 1 characterised in that said phase control means (120,220) is operable to cause the undesired component to reach said output terminal (114,214) substantially 180° out of phase with the corresponding component from the first path, and said amplifier means (122,222) is operable to cause the undesired component to reach said output terminal substantially equal in amplitude to the corresponding component from the first path.

3. A system according to Claim 1 or Claim 2 characterised by a plurality of said second paths each including filter means (118) to select a different said undesired harmonically related component.

4. A system according to any one of Claims 1 to 3 characterised in that said signal to be transmitted is a fundamental component, and the or each said undesired component is a harmonic of said fundamental.

5. A system according to any one of Claims 1 to 3 characterised in that said signal to be transmitted is a harmonic component, and the undesired components are the fundamental component and another harmonic of said fundamental.

6. A system according to any one of Claims 1 to 5 characterised in that said phase control means (120,220) and said amplifier means (122,222) in the or each said second path are adjustable to permit minimization of the power of any said undesired component in the signal to be transmitted.

7. A system according to Claim 6 characterised by means (228,238,256) for automatic adjustment of said phase control means (220) to tend to cause the undesired component in the second path to reach said output terminal substantially 180° out of phase with the corresponding component from the first path.

8. A system according to Claim 7 characterised by means (228,238,258) for automatic adjustment of said amplifier means (222) to tend to cause the undesired component in the second path to reach said output terminals substantially equal in amplitude to the corresponding component from the first path.

9. A system according to Claim 8 characterised in that said phase adjustment means and amplifier adjustment means (228,238,256,258) comprise:

sample means (228,230) for sampling an output from said output terminal (214);

filter means (232) for selecting a said undesired component in said sample;

a detector (234) to detect the output of the filter means;

a null detector (260) connected to the output of said detector;

gate means (242,244) to gate alternately the phase control means (220) and the adjustable amplifier means (222);

means (238,248,250) to alter the level of a control voltage fed to the phase control means (220) to adjust the phase as an inverse function of the level of the detected undesired component;

said gate means (242) gating off said control voltage when said null detector (260) indicates a null;

storage means (256) to store said gated off control voltage;

means (238,252,254) to alter the level of a second control voltage fed to the adjustable amplifier means (222) to adjust the amplitude as an inverse function of the level of the detected undesired component;

said gate means (244) gating off said second control voltage when said null detector (260) indicates a null; and

second storage means (258) to store said gated off second control voltage.

10. A method for reducing power of any undesired harmonically related component in a radio frequency (rf) power signal to be transmitted by a transmitter;

characterised by:

coupling the output of a power amplifier along a first path to an output terminal, said first path passing said signal while attenuating the or

each said undesired component by at least 6 db;

selectively passing a said undesired component along a second path from said power amplifier to said output terminal; and

controlling the phase and the amplitude of the undesired component in said second path to cause the undesired component to reach said output terminal with a phase and amplitude relative to the phase and amplitude of the corresponding component reaching said terminal from the first path to tend to reduce the power of the undesired component at said output terminal.

Patentansprüche

1. Anordnung zur Verminderung der Leistung von ungewünschten harmonischen Schwingungskomponenten innerhalb eines Hochfrequenzleistungssignals, welche von einen Sender zur Abstrahlung gelangt, **gekennzeichnet** durch
   - einen ersten Signalpfad zum Verbinden des Ausgangs eines Leistungsverstärkers (102,202) mit einer Ausgangsklemme (114, 214), wobei dieser erste Signalpfad das eigentliche Signal hindurchläßt, während das oder die ungewünschten Frequenzkomponenten um wenigstens 6 db bedämpft werden sowie
   - einem zweiten Signalpfad zum selektiven Hindurchleiten des oder der ungewünschten Frequenzkomponenten des Leistungsverstärkers (102,202) an die Ausgangsklemme (114,214), wobei dieser zweite Signalpfad Phasensteuereinheiten (120,220) sowie Verstärkereinheiten (122,222) aufweist, mit welchen die der Ausgangsklemme zugeführte ungewünschte Signalkomponente sowohl phasen- wie auch amlplitudenmäßig in Bezug auf die Phase und Amplitude der über den ersten Signalpfad zugeführten Signals derart verändert wird, daß auf diese Weise die Leistung der ungewünschten Signalkomponente an der Ausgangsklemme reduzierbar ist.

2. Anordnung nach Anspruch 1, dadurch **gekennzeichnet**, daß die Phasensteuereinheit (120, 220) derart ausgelegt ist, daß die der Ausgangsklemme (114,214) zugeführte ungewünschte Signalkomponente phasenmäßig im wesentlichen 180° gegenüber der entlang der ersten des ersten Signalpfades geführten Signalkomponente versetzt ist, während die Verstärkereinheit (122,222) derart betrieben wird, daß die der Ausgangsklemme zugeführte ungewünschte Signalkomponente amplitudenmäßig im wesentlichen gleich der entlang des ersten Signalpfades geleiteten Signalkomponente ist.

3. Anordnung nach Anspruch 1 oder 2, dadurch **gekennzeichnet**, daß eine Mehrzahl von zweiten Signalpfaden mit entsprechenden Filtereinheiten (118) vorgesehen ist, mit welchen unterschiedliche ungewünschte harmonische Komponenten zur Auswahl gelangen.

4. Anordnung nach einem der Ansprüche 1 bis 3, dadurch **gekennzeichnet**, daß das zu übertragende Signal die Grundkomponente ist, während das oder die ungewünschten Signalkomponenten Harmonische der Grundkomponente sind.

5. Anordnung nach einem der Ansprüche 1 bis 3, dadurch **gekennzeichnet**, daß das zu übertragende Signal eine harmonische Komponente ist, während die ungewünschten Komponenten die Grundkomponente und andere Harmonische der Grundkomponente sind.

6. Anordnung nach einem der Ansprüche 1 bis 5, dadurch **gekennzeichnet**, daß die in den einzelnen zweiten Signalpfaden angeordneten Phasensteuereinheiten (120,220) und Verstärkereinheiten (122,222) einstellbar sind, um auf diese Weise eine Minimisierung der Leistung der verschiedenen ungewünschten Frequenz-komponenten innerhalb des zu übertragenden Signals zu erreichen.

7. Anordnung nach Anspruch 6, dadurch **gekennzeichnet**, daß Einheiten (228,238,256) zur automatischen Einstellung der Phasenschiebereinheiten (220) vorgesehen sind, welche derart arbeiten, daß die über den zweiten Signalpfad geleitete ungewünschte Signalkomponente die Ausgangsklemme im wesentlichen um 180° phasenverschoben gegenüber der entlang des ersten Signalpfades geführten Signalkomponente erreicht.

8. Anordnung nach Anspruch 7, dadurch **gekennzeichnet**, daß Einheiten (228,238,256) zur automatischen Einstellung der Verstärkereinheiten (220) vorgesehen sind, welche derart arbeiten, daß die entlang des zweiten Signalpfades geleitete ungewünschte Signalkomponente die Ausgangsklemme im wesentlichen mit der gleichen Amplitude wie die entsprechende entlang des ersten Signalpfades geleitete Signalkomponente erreichen.

9. Anordnung nach Anspruch 8, dadurch **gekennzeichnet**, daß die Phasen- und Verstärkereinstelleinheiten (228,238,256,258) wie folgt aufgebaut sind:

- Abtasteinheiten (228,230) zur Probenwertentnahme des Ausgangssignals an der Ausgangsklemme (214);
- eine Filtereinheit (232), welche innerhalb der Probenwertentnahme eine ungewünschte Signalkomponente auswählt;
- einem Detektor (234), welcher das Ausgangssignal der Filtereinheit feststellt:
- einem Null-Detektor (260), welcher mit dem Ausgang des Detektors verbunden ist;
- zwei Toreinheiten (242,244), welche ausgangsseitig an der Phasensteuereinheit (220) und der einstellbaren Verstärkereinheit (222) angeschlossen sind;
- Einheiten (238,248,250), welche der Pegelwert der der Phasensteuereinheit (220) zugeführten Steuerspannung derart verändern, um die Phase entsprechend einer Inversfunktion des Pegelwertes der festgestellten ungewünschten Komponente einzustellen, wobei die erste Toreinheit (242) die betreffende Steuerspannung absperrt, sobald der Null-Detektor (260) einen Null-Wert anzeigt,
- eine erste Speichereinheit (256), welche die abgesperrte Steuerspannung speichert;
- Einheiten (238,252,254), welche den Pegelwert einer der einstellbaren Verstärkereinheit (222) zugeführten zweiten Steuerspannung derart verändert, daß die Amplitude als eine Inversfunktion des Pegels der festgestellten ungewünschten Komponente eingestellt wird, wobei die zweite Toreinheit (244) die zweite Steuerspannung absperrt, sobald der Null-Detektor (260) einen Null-Wert anzeigt, und
- eine zweite Speichereinheit (258), welche die abgeschaltete zweite Steuerspannung speichert.

10. Verfahren zur Verringerung der Leistung von ungewünschten harmonischen Komponenten bei einem Hochfrequenzleistungssignal, welches über einen Sender zur Aussendung gelangt, **gekennzeichnet** durch die folgenden Verfahrensschritte
    - Zuführen des Ausgangssignals eines Leistungsverstärkers entlang eines ersten Signalpfades an eine Ausgangsklemme, wobei dieser erste Signalpfad das betreffende Signal hindurchleitet, während das oder die ungewünschten Signalkomponenten um wenigstens 6 db bedämpft werden;
    - selektives Hindurchleiten der ungewünschten Signalkomponente entlang eines zweiten Signalpfades von dem Leistungsverstärker an die Ausgangsklemme und
    - Steuern der Phase und der Amplitude der entlang des zweiten Signalpfades geleiteten ungewünschten Signalkomponente derart, daß diese ungewünschte Signalkomponente die Ausgangsklemme mit einer Phase und Amplitude in Bezug auf die Phase und Amplitude der die Ausgangsklemme über den ersten Signalpfad zugeleiteten Komponente erreicht, um auf diese Weise die Leistung der ungewünschten Signalkomponente an der Ausgangsklemme zu verringern.

Revendications

1. Un système pour réduire la puissance de toute composante indésirable présentant une relation harmonique dans un signal de puissance radiofréquence (RF) à émettre par un émetteur ;
   caractérisé par :
   un premier chemin pour coupler la sortie d'un amplificateur de puissance (102, 202) à une borne de sortie (114, 214), ce premier chemin laissant passer le signal précité tout en atténuant d'au moins 6 dB la composante indésirable, ou chacune d'elles ;
   un second chemin pour transmettre sélectivement une composante indésirable, de l'amplificateur de puissance (102, 202) vers la borne de sortie (114, 214) ;
   ce second chemin comprenant des moyens de commande de phase (120, 220) et des moyens amplificateurs (122, 222) que l'on peut faire fonctionner d'une manière telle que la composante indésirable atteigne la borne de sortie avec une phase et une amplitude, par rapport à la phase et à l'amplitude de la composante correspondante atteignant cette borne à partir du premier chemin, qui tendent à réduire la puissance de la composante indésirable sur la borne de sortie.

2. Un système selon la revendication 1, caractérisé en ce que l'on peut faire fonctionner les moyens de commande de phase (120, 220) de façon que la composante indésirable atteigne la borne de sortie (114, 214) en étant déphasée pratiquement de 180° par rapport à la composante correspondante provenant du premier chemin, et en ce qu'on peut faire fonctionner les moyens amplificateurs (122, 222) pour faire en sorte que la composante indésirable atteigne la borne de sortie avec une amplitude pratiquement égale à celle de la composante correspondante provenant du premier chemin.

3. Un système selon la revendication 1 ou la reven-

dication 2, caractérisé par un ensemble des seconds chemins, comprenant chacun un filtre (118) pour sélectionner l'une différente des composantes indésirables liées de façon harmonique.

4. Un système selon l'une quelconque des revendications 1 à 3, caractérisé en ce que le signal à émettre est une composante de fondamental, et la composante indésirable, ou chacune d'elles, est un harmonique de ce fondamental.

5. Un système selon l'une quelconque des revendications 1 à 3, caractérisé en ce que le signal à émettre est une composante harmonique, et les composantes indésirables sont la composante de fondamental et un autre harmonique de ce fondamental.

6. Un système selon l'une quelconque des revendications 1 à 5, caractérisé en ce que les moyens de commande de phase (120, 220) et les moyens amplificateurs (122, 222) dans le second chemin ou dans chacun d'eux, sont réglables pour permettre de minimiser la puissance de toute composante indésirable dans le signal à émettre.

7. Un système selon la revendication 6, caractérisé par des moyens (222, 238, 256) pour régler automatiquement les moyens de commande de phase (220) de façon qu'ils tendent à faire en sorte que la composante indésirable dans le second chemin atteigne la borne de sortie en étant pratiquement déphasée de 180° par rapport à la composante correspondante qui provient du premier chemin.

8. Un système selon la revendication 7, caractérisé par des moyens (228, 238, 258) pour le réglage automatique des moyens amplificateurs (222) de façon qu'ils tendent à faire en sorte que la composante indésirable dans le second chemin atteigne la borne de sortie avec une amplitude pratiquement égale à celle de la composante correspondante provenant du premier chemin.

9. Un système selon la revendication 8, caractérisé en ce que les moyens de réglage de phase et les moyens de réglage d'amplificateur (228, 238, 256, 258) comprennent :

des moyens d'échantillonnage (228, 230) pour échantillonner un signal de sortie provenant de la borne de sortie (214) ;

des moyens de filtrage (232) pour sélectionner une composante indésirable dans l'échantillon précité ;

un détecteur (234) pour détecter le signal de sortie des moyens de filtrage ;

un détecteur de zéro (260) connecté à la sortie du détecteur précité ;

des moyens à portes (242, 244) pour activer alternativement les moyens de commande de phase (220) et les moyens amplificateurs réglables (222) ;

des moyens (238, 248, 250) pour modifier le niveau d'une tension de commande qui est appliquée aux moyens de commande phase (220), pour régler la phase selon une fonction inverse du niveau de la composante indésirable détectée ;

les moyens à portes (242) bloquant la tension de commande précitée lorsque le détecteur de zéro (260) indique un zéro ;

des moyens de mémorisation (256) pour mémoriser la tension de commande bloquée ;

des moyens (238, 252, 254) pour modifier le niveau d'une seconde tension de commande qui est appliquée aux moyens amplificateurs réglables (222), de façon à régler l'amplitude selon une fonction inverse du niveau de la composante indésirable détectée ;

les moyens à portes (244) bloquant cette seconde tension de commande lorsque le détecteur de zéro (260) indique un zéro ; et

des seconds moyens de mémorisation (258) pour mémoriser la seconde tension de commande bloquée.

10. Un procédé pour réduire la puissance de toute composante indésirable présentant une relation harmonique dans un signal de puissance radiofréquence (RF) à émettre par un émetteur ;

caractérisé en ce que

on couple la sortie d'un amplificateur de puissance à une borne de sortie, par un premier chemin, ce premier chemin transmettant ce signal tout en atténuant d'au moins 6 dB la composante indésirable, ou chacune d'elles ;

on transmet sélectivement une composante indésirable précitée par un second chemin, de l'amplificateur de puissance vers la borne de sortie ; et

on commande la phase et l'amplitude de la composante indésirable dans le second chemin pour faire en sorte que la composante indésirable atteigne la borne de sortie avec une phase et une amplitude, par rapport à la phase et à l'amplitude de la composante correspondante qui atteint cette borne à partir du premier chemin, qui tendent à réduire la puissance de la composante indésirable sur la borne de sortie.

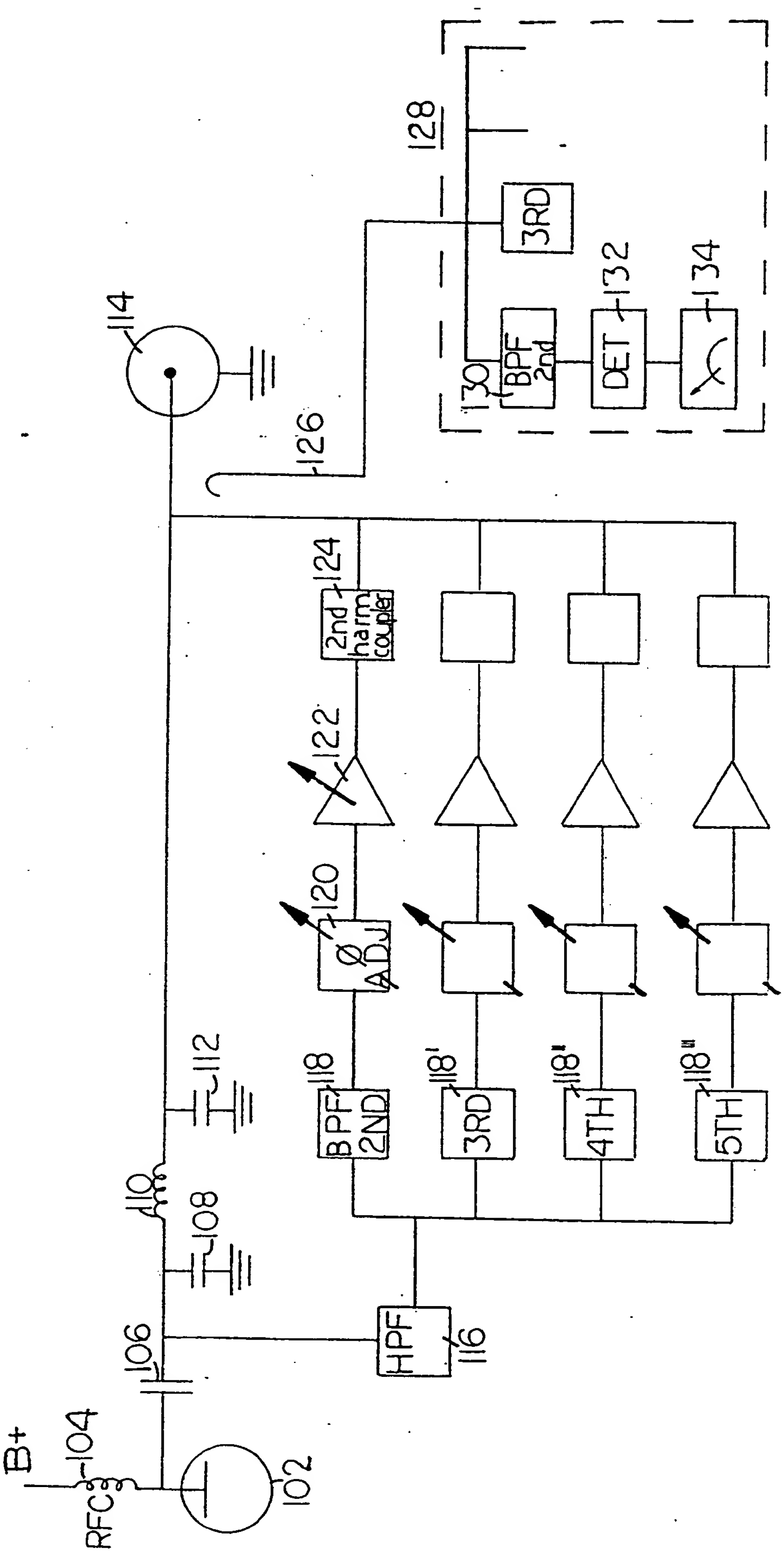
B+
RFC
104
102
106
108
110
112
114
HPF
116
BPF 2ND
118
3RD
118'
4TH
118''
5TH
118'''
Ø ADJ
120
122
2nd harm coupler
124
126
128
3RD
BPF 2nd
130
DET
132
134

FIG. 1

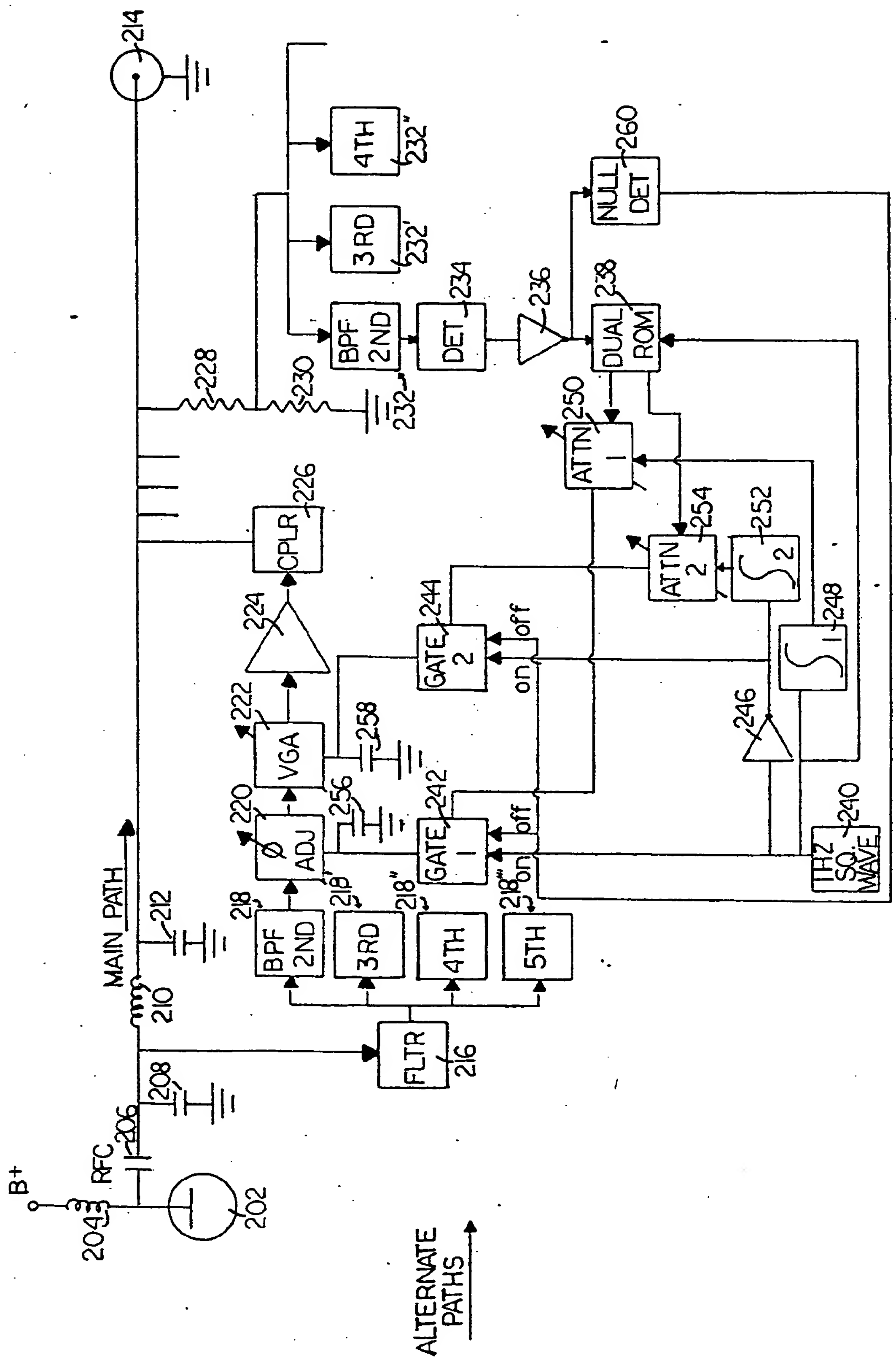

FIG. 2

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